

Public Health Assessment for

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, TULSA COUNTY, OKLAHOMA
CERCLIS NO. OKD987096195
JULY 27, 2000

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

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PUBLIC HEALTH ASSESSMENT

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COLLINSVILLE, TULSA COUNTY, OKLAHOMA

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Prepared by:

Superfund Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations - the structure may vary from site to site. Nevertheless, the public health assessment process is not considered complete until the public health issues at the site are addressed.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly, chronically ill, and people engaging in high risk practices), they will be summarized in the conclusion section of the report. Ways to stop or reduce exposure will then be recommended in the public health action plan.

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

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SUMMARY

The Tulsa Fuel and Manufacturing Company operated a zinc smelter and lead roaster from 1914 through 1925 on a 50-acre site just south of the city of Collinsville, Tulsa County, Oklahoma. The site was originally reported to the Environmental Protection Agency (EPA) as Acme Brick Strip Mines, and later corrected to the current name, Tulsa Fuel and Manufacturing (TFM) site. The majority of the facility structures have since been demolished and the site is currently covered with approximately 30,000 cubic yards of waste material from the smelter operation. A home also exists on-site near the former office building and has been occupied since 1935. The TFM site was listed on the National Priorities List in January 1999.

Sampling data of the on-site soil, sediment, and surface water show elevated levels of metal contaminants, including arsenic, cadmium, copper, lead, manganese, and zinc. Limited sampling data exist for on-site groundwater and off-site soil, sediment, and surface water.

Exposure to the site contaminants are limited by the isolated, rural location of the site. Some recreational activity has occurred on the site, such as fishing, but it is assumed that the number of people fishing is small. The only access road to the site leads to the on-site residence, where one adult man lives.

Currently, the TFM site poses no apparent health hazard because of the limited exposure to on-site soils, sediment, and surface water. Frequent, long-term exposure to on-site soil would be a health concern. The Agency for Toxic Substances and Disease Registry (ATSDR) is unable to evaluate the health implications of *off-site* contamination because of the limited data available. EPA is planning to conduct a remedial investigation, in the near future, which will address environmental data gaps at the TFM site.

ATSDR recommends that access to the site be restricted and that future residential exposures be considered in soil removal or remedial efforts. Because of limited off-site sampling data, ATSDR also recommends that extent of contamination from the TFM site be determined and that, as a precaution, young children in the area should have their blood tested for lead.

PURPOSE AND HEALTH ISSUES

In this public health assessment, the Agency for Toxic Substances and Disease Registry (ATSDR) evaluates the public health significance of the Tulsa Fuel and Manufacturing (TFM) site in Tulsa County, Oklahoma. ATSDR has reviewed available environmental and health outcome data and community health concerns to determine whether adverse health effects are possible. In addition, these evaluations considered whether actions are needed to reduce, prevent, or further identify the possibility for site-related exposure and associated adverse health effects.

As a former smelter, the health concern at the TFM site is focused on metal contamination. Most of the environmental sampling conducted so far has been on the site itself; therefore, the health evaluation of exposure to *on-site* contaminants will be addressed in this document. As more off-site data become available, ATSDR will then evaluate the associated exposure pathways.

ATSDR, an agency of the U.S. Department of Health and Human Services, is required to conduct public health assessments of sites proposed for the National Priorities List (NPL), under authorities provided by the Superfund law (Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERCLA]) and its amendments. The U.S. Environmental Protection Agency (EPA) proposed in September 1998 that the Tulsa Fuel and Manufacturing site be added to the NPL. It was finalized on the list in January 1999.

BACKGROUND

Site Description and History

Tulsa Fuel and Manufacturing Company (TFM) operated a zinc smelter and lead roaster on this 50-acre site from 1914 through 1925. The site was formerly known as Acme Brick Strip Mines. It is located approximately 12 miles north of Tulsa and 1 mile south of Collinsville, Tulsa County, Oklahoma. Old Highway 169 and railroad tracks form the eastern boundary of the site and a former strip mining operation borders the site to the south. Agricultural lots are located to the north and west. See Figure 1 in Appendix A for a map of the area. (1)

The former smelting operation utilized nine furnaces, a mechanical kiln building, a condenser room, a two-million gallon reservoir, and a laboratory at this site. The furnaces were likely fueled by natural gas from nearby wells. Large amounts of ore were stored in the northeastern area of the site. (2)

The majority of the facility structures have been demolished. The site is currently covered with approximately 30,000 cubic yards of waste consisting of broken retorts, condensers, slag, building

debris, ash, bricks, and other materials derived from the smelting operations. Vegetation is sparse on most of the site. (3, 4)

Three ponds, which are assumed to be remnants of the old reservoir, are located in the northern area of the site. A water-filled impoundment is located immediately south of the site and is part of the former strip mining area (1, 5). A home exists on-site near the former office building and has been occupied since 1935. The residence has a water well, which was used in the past to obtain drinking water (2). See Figure 2 for a sketch of the site.

Although the site has a fence on one side, access is possible. Fishing activity in the northern ponds and in the southern impoundment have been reported on several occasions (5, 6, 7). A goat has been observed on the site several times, but it is not known to whom the goat belongs or if it is used for milk (5). In addition, the Oklahoma Department of Environmental Quality (ODEQ) stated recently that individuals were picking blackberries on the site.

A number of visits and investigations have been conducted by the ODEQ for this site. The Environmental Protection Agency (EPA) recently completed a Removal Assessment Report (4) and is planning to conduct a remedial investigation at this site in the near future.

ATSDR Site Visit

ATSDR representatives visited the site and community on July 27-28, 1999. The Oklahoma Department of Environmental Quality (ODEQ) and U.S. Environmental Protection Agency (EPA) representatives led the tour of the site. Waste from smelter activity covers most of the site. Vegetation on the site was patchy, thick in some areas because of recent rain and bare in other areas. Some of the waste piles from the old smelter were approximately 10 feet high. In the northeast corner of the site, the waste material sloped down to a drainage ditch next to the railroad. A large waste pile was observed next to the southern impoundment and appears to have eroded into the water in the past. No recreational activity, such as fishing, was observed during this site visit, but there was evidence of past activity near the southern impoundment.

The only direct road to the site leads to a single-family home, occupied by an adult man. No children live on the site. The on-site resident has had a number of conversations with ODEQ representatives in the past and is aware of the contamination from the smelter. He expressed no health concerns about the site to ATSDR staff during the site visit.

A public meeting was held on July 27, 1999, at the Collinsville City Hall Annex, in order to update the citizens on future site activities, to introduce the various agencies involved, and to gather community concerns. The health concerns of community members are listed later in this document.

Demographics, Land Use, and Natural Resources

Besides the one resident currently living on-site, the next closest dwellings are located about ½ mile southeast of the site, across the railroad tracks and Old Highway 169, in a trailer park. According to the 1990 census, there are 1463 persons living within one mile of the site, which would include part of the city of Collinsville. Of these individuals, 88% of the people are White and 12% are American Indian, Eskimo, or Aleutian. Approximately 147 children, ages 6 and under, live within one mile of the site. See Figure 1 in Appendix A.

The area immediately surrounding the Tulsa Fuel and Manufacturing site is mostly agricultural, except for the former Acme Brick strip mine area to the south. Another smelter operated in the area from 1910 to 1918. It was called the Collinsville Smelter and was located about ½ mile to the northeast of the TFM site. Currently, there are no facilities within five miles of the site reporting a hazardous substance release to the environment, according to the 1997 Toxic Release Inventory database. The predominant wind direction in the area is to the north-northeast and secondarily to the south-southeast, according to area wind roses (8).

Surface water runoff from the site flows to the eastern side of the site, where it collects in ditches that parallel the railroad tracks. The water then flows through a culvert under the tracks and Old Highway 169 into a wetland on the east side of the highway. The water pools in this wetland and may gradually flow towards Blackjack Creek. The creek flows intermittently for about a mile before it reaches a point where it flows year-round. Blackjack Creek eventually flows into Horsepen Creek and the Caney River. The creeks and river are not drinking water resources for the area. (1, 5)

Although groundwater is not widely utilized in the area, there is one private well on-site, at a depth of 50 feet, which has been used for drinking water in the past. Currently, the occupant does not use the well for drinking water because of concerns about bacterial contamination (3). No public water supply wells are located within four miles of the site. There are thirteen private wells within four miles of the site, although only the well on-site is within a one mile radius. (1)

Health Outcome Data

The superfund law requires that health outcome (i.e., mortality and morbidity) data (HOD) be considered in a public health assessment (9). This consideration is done following ATSDR's *Public Health Assessment Guidance Manual* and a 1996 amendment to that document (10, 11). The main requirements to evaluate health outcome data are presence of a completed human exposure pathway, great enough contaminant levels to result in measurable health effects, sufficient people in the completed pathway for the health effect to be measured, and a health outcome database where disease rates for populations of concern can be identified.

This site does not meet the requirements for including an evaluation of health outcome data in a public health assessment. While there are completed human exposure pathways at this site, neither the contaminant levels nor the exposed population are great enough to result in a meaningful measurement of health outcome data.

DISCUSSION

Contaminant Selection

ATSDR reviewed environmental sampling data (1, 4) and selected contaminants of potential concern that warranted further evaluation for exposure and public health significance. The contaminants selected include:

antimony	lead
arsenic	manganese
cadmium	zinc
copper	

The tables in Appendix B list the contaminants and their concentrations found in soil, sediment, and water. Only the chemicals that exceed a certain environmental screening level are included for further evaluation. The screening levels, or comparison values, are conservative (i.e. protective) values that would be unlikely to cause health effects even if a person were exposed daily to the chemical. The comparison values are described in Appendix C.

The soil on and around the Tulsa Fuel and Manufacturing (TFM) site was sampled and analyzed for metals during the 1994 Site Investigation and the 1999 Removal Assessment Report. For the Site Investigation, a limited number of judgmental samples were taken. Judgmental sampling is when a location to be sampled is chosen for some particular reason; in this case, the areas sampled were believed to have high levels of contaminants or to be in areas of high exposure.

For the Removal Assessment Report, a large number of judgmental and random samples (from a grid pattern) were taken and most were analyzed on-site using X-Ray Fluorescence spectroscopy (XRF) techniques. This type of soil analysis is useful because it can provide a large number of quick results that can be read in the field. However, it is considered to be a screening effort only, and generally 10% of the samples are also sent to a laboratory for confirmation analysis (12). For this Removal Assessment Report, only 9 samples, about 4%, were sent for confirmation. The

XRF data were only included in this public health assessment if they were confirmed by laboratory results (where $R^2 > 0.7$)¹.

The surface soil at the TFM site was sampled for metals from 0 to 6 inches in depth. Over a hundred samples were taken from across the entire site, from the road at the northern edge of the site, and from the residential property on the site. Lead was found at a maximum of 36,500 ppm (parts per million). Other metals detected above the comparison values are arsenic, cadmium, manganese, and zinc, as listed in Table B1, Appendix B. The distribution of arsenic, lead, and cadmium levels across the site are mapped in Appendix A, Figures 3, 4, and 5, respectively.

Radiation was also screened for during a site walk-through in 1999. No ionizing radiation was detected. (4)

The subsurface soil was sampled at forty waste pile locations for the Removal Assessment. Samples were taken at three different depths according to their composition: slag, slag/clay mixture, and clay. The depths varied from location to location; some of the slag extended as deep as nine feet. Table B2 in Appendix B lists the results from the slag analysis, since this material will have the highest concentrations of smelter contaminants. The soil under the road was sampled at a depth of 2 to 24 inches. Arsenic, cadmium, lead, manganese, and zinc were detected above their comparison values.

Off-site surface soil results are listed in Tables B3. Only eight surface soil samples have been collected off-site, mostly to the north, and may not be representative of other areas around the site. The trailer park nearest the site was not sampled because the top soil there had allegedly been replaced. Eight samples of subsurface soil were taken at six locations off-site, from 2 to 36 inches below the surface. Although some of the metal concentrations are above comparison values, they are much lower than site concentrations. Maximum concentrations of arsenic, cadmium, lead, manganese, and zinc were found slightly above comparison values.

The Oklahoma Department of Environmental Quality reported that, at other smelter sites in Oklahoma, slag or waste material has been transported off-site to be used as fill in driveways or in school running tracks (13). This could have occurred in the past at the TFM site since it was abandoned in the 1920s and large amounts of slag material were left behind. No sampling data have been taken, nor any investigation conducted, to evaluate this possibility.

¹ R^2 (square correlation coefficient) is a statistical parameter which describes the linear relationship between two sets of data. R^2 ranges from 0 to 1; with higher numbers indicating good correlation. In this case, if R^2 is greater than 0.7, we conclude that the XRF data is similar enough to the laboratory analysis data to be used with confidence (12).

Sediment samples were collected in the northern ponds and in the southern impoundment for both the 1994 and 1999 reports (see Table B4, Appendix B). The same metals that are elevated in the on-site soil are also above the comparison values in the sediment. Higher concentrations were reported in the 1994 Site Investigation than in the 1999 Removal Assessment. This could be because the earlier sampling event targeted contaminated areas (judgmental sampling) and the later report took random samples from each body of water.

Five off-site sediment samples were taken for the Site Investigation. All were below comparison values or near background levels. The locations for these samples, downstream from the TFM site, could also be influenced by another former smelter site to the northeast of TFM.

Surface water results from the on-site ponds and southern impoundment indicated that arsenic, cadmium, lead, and manganese exceed their comparison values for drinking water (see Table B5, Appendix B). The surface water bodies are not used for drinking water, but may be used for recreational purposes. The 1994 off-site surface water samples, collected downstream from the site, were not above the drinking water comparison values, except for manganese. Manganese was detected at a maximum concentration of 262 parts per billion (ppb).

Only one groundwater sample has been analyzed for this site. In 1992, the Oklahoma State Department of Health sampled the on-site residential well for bacteria and total metals. The sample was collected from the kitchen faucet. Coliform bacteria were detected in the well water, which could indicate surface water contamination. For the metals, only barium and zinc were detected, but they were below their comparison values (14). Other site-related metals were not detected, however the detection limits for some of these metals were above their comparison values.

The air was sampled during the 1999 Removal Assessment activities. Respirable and total suspended particulates at five locations were collected continuously over a 24-hour period for five days. None of the metals detected were above their comparison value. The maximum concentration of lead measured in the air was $0.13 \mu\text{g}/\text{m}^3$ (microgram per cubic meter), which is approximately ten times less than the National Ambient Air Quality Standard for lead ($1.5 \mu\text{g}/\text{m}^3$). No record of air quality during the smelter operation has been found. However, based on information regarding typical horizontal smelters of that era, releases of sulfur dioxide and metal fumes were likely in the past (15).

Seven catfish (8 to 18 inches long) were caught in the southern impoundment and the fillets were analyzed for metals (4). No fish were observed in the northern ponds. The three metals that were detected in the catfish fillets were below their comparison values.

Identifying contaminants for further assessment does not imply that human exposure would actually result in adverse health effects. The significance of any exposure to those contaminants

and the potential for associated health effects are established through further evaluation. An overview of this evaluation process is provided in Appendix D.

Exposure Pathways

ATSDR examined plausible exposure pathways and their associated contaminants and identified several pathways that warranted further evaluation for potential health effects. The pathways selected for more evaluation are presented in Table B6 (Appendix B) and include exposure to the soil, sediment, and surface water on-site. The people most likely exposed to the contaminants on the site would be the current resident and those who frequently visit or trespass on the site. The current resident reportedly spends only a small amount of time each day in the yard (personal communication with resident, June 2000). Trespassing on the site has been observed in the past, but is assumed to be limited since the site is in an isolated area. If the occupancy of the on-site residence changes in the future, the exposure to contamination may increase significantly, especially if children live there.

Several of the plausible exposure pathways did not warrant further evaluation for health impact because the exposure, if any, would not be at levels that would affect human health. In some cases, further evaluation was impossible because environmental sampling data was not available to estimate exposure doses. Those pathways are outlined in Table B7 (Appendix B). Some of these pathways may be addressed in the future when sampling data are available.

During the operation of the smelter from 1914 to 1925, exposure of workers to contaminants is likely. However, it is not possible to evaluate the health implications since the contaminant levels, the exposure duration, the exposure frequency, the extent of personal protection, and other factors are not known. Therefore, this type of exposure will not be discussed further.

Public Health Implications

In this section, the public health implications of chemicals in the on-site soil, sediment, and surface water environmental exposure pathways that have at least one concentration above a comparison value are discussed. For the on-site soil exposure pathway, these chemicals are arsenic, cadmium, copper, lead, manganese, and zinc. For the on-site sediment exposure pathway, they are arsenic and cadmium. For the surface water pathway, arsenic was the only chemical above a comparison value.

Introduction

Identification of the public health implications of a site focuses on identifying which chemicals and exposure situations could be a health hazard. The first step is the calculation of child and adult exposure doses, as described in Appendix E. These are then compared to an appropriate health

guideline for that chemical. The results of these calculations are presented in Tables E1 through E3 starting on page 37. Any exposure situation, where the exposure dose is lower than a health guideline, is eliminated from further evaluation.

The next step is the revision of the exposure dose to better match probable rather than worst-case exposure scenarios. Lastly, these revised exposure doses are compared to known toxicological values for the chemical of concern. This would include the no observed adverse health effect level (NOAEL) and the lowest observed adverse health effect level (LOAEL) identified in ATSDR Toxicological Profiles. If the chemical of concern is a carcinogen, the cancer risk is recalculated using the revised exposure dose. These comparisons are the basis for stating whether or not the exposure is a health hazard.

Possible Health Consequences of Chemicals

There were health guidelines to identify the risk of non-cancer health effects for all 6 chemicals of concern except lead. There was a health guideline to identify cancer risk for arsenic, but not for the other possible human carcinogens, cadmium and lead. Copper, manganese, and zinc are not considered carcinogens.

Soil Exposure Pathway

The exposure doses and cancer risk for the chemicals in this pathway are displayed in Table E1. The possible health consequences are discussed in the following paragraphs.

Arsenic

Health effects due to arsenic in the Tulsa Fuel on-site soil exposure pathway could occur if a child had regular exposure to contaminated soil. Health effects in adults are unlikely. The adult and child exposure doses for the maximum arsenic concentrations of 864 ppm are above the health guideline for non-carcinogenic health effects. The child exposure dose for the mean arsenic level of 138 ppm was above the arsenic health guideline, while for the mean, the adult exposure dose was below.

Exposure of small children (under 5 years old) could result in adverse health effects if a child played on arsenic-contaminated soil on the site nearly every day. At the maximum level of 864 ppm, daily contact for a few minutes might be sufficient for health effects, while at the mean level of 138 ppm, contact would have to be for several hours a day. However, it appears that small children do not currently have the opportunity for frequent contact since no children reside on-site. It is also unlikely that small children living offsite could regularly access the contaminated areas since there are no residences within about ½ mile of the contaminated areas, other than the one house on-site. It is occupied by an adult man.

An adult would have to have prolonged contact with soil contaminated at or near the maximum concentration of 864 ppm for 4-5 days a week for an increased risk of health effects. Currently, this is unlikely since no one works at the site and the individual living on-site reportedly spends a limited amount of time outside.

The cancer risk for the maximum and mean arsenic levels are elevated if someone were exposed to those levels nearly every day for 70 years. ATSDR calculations indicate that the mean arsenic level would increase cancer risk only if there was daily exposure for at least 30 years, and for the maximum level, if there was daily exposure for at least 10 years. It appears unlikely that anyone could meet these exposure circumstances since no one works on site and the individual living on-site reportedly spends a limited amount of time outside.

Cadmium

Health effects in children or adults due to exposure to cadmium in soil from this site appear unlikely based on the contaminant levels or the likely exposure scenarios. As indicated in Table E1, the child exposure dose for both the mean and maximum cadmium levels exceed the health guideline, while the adult exposure doses do not. Thus, adults will not be considered further in evaluating the possibility of health effects for cadmium.

Health effects in children appear unlikely because they do not have the opportunity to have sufficient exposure to result in harm. The calculated exposure doses for children assume that a 2 to 3 year old child would have nearly daily contact with contaminated soil for several hours a day. As discussed for arsenic, there are currently no children living on-site and it does not appear likely that small children from neighboring residences would access the site because of the distances involved.

Copper

Health effects in children or adults due to exposure to copper in soil from this site appear unlikely based on the contaminant levels or the likely exposure scenarios. As indicated in Table E1, the child exposure dose for the maximum copper level exceeds the health guideline, but for the mean it does not. The adult exposure doses for the mean and maximum levels do not exceed the health guideline; therefore, adults will not be considered further in evaluating the possibility of health effects for copper.

Health effects in children appear unlikely because they do not have the opportunity to have sufficient exposure to result in harm. The calculated child exposure dose for the maximum copper level assumes that a 2 to 3 year old child would have nearly daily contact with contaminated soil several hours a day. As discussed for arsenic, there are currently no children living on-site and it

does not appear likely that small children from neighboring residences would access the site because of the distances involved.

Lead

A review of the ATSDR Toxicological Profile for Lead indicates that daily exposure to lead at any location where lead levels were above 400 ppm, could be a health hazard for children less than 6 years old (20). However, it is very unlikely that small children could have enough exposure to result in health effects because it appears unlikely that they could access the contaminated soil. Currently, no children live on-site and the nearby residences are too far away for a small child to have regular exposure.

The higher lead levels found on-site could cause health effects in adults if there was exposure to these concentrations all day nearly every day (20). As described before, there is no one, at present, that meets this exposure scenario.

Manganese

Health effects in children or adults due to exposure to manganese in soil from this site appear unlikely based on the contaminant levels or the likely exposure scenarios. As indicated in Table E1, the child exposure dose for both the mean and maximum manganese levels exceed the health guideline, while the adult exposure doses do not. Thus, adults will not be considered further in evaluating the possibility of health effects for manganese.

Health effects in children appear unlikely because they do not have the opportunity to have sufficient exposure to result in harm. The calculated exposure doses for children assume that a 2 to 3 year old child would have nearly daily contact with contaminated soil several hours a day. As discussed for arsenic, there are currently no children living on-site and it does not appear likely that small children from neighboring residences would access the site because of the distances involved.

Zinc

Health effects in children or adults due to exposure to zinc in soil from this site appear unlikely based on the contaminant levels or the likely exposure scenarios. As indicated in Table E1, the child exposure dose for both the mean and maximum zinc levels exceed the health guideline, while the adult exposure doses do not. Thus, adults will not be considered further in evaluating the possibility of health effects for zinc.

Health effects in children are unlikely because they do not have the opportunity to have sufficient exposure to result in harm. The calculated exposure doses for children assume that a 2 to 3 year

old child would have nearly daily contact with contaminated soil several hours a day. As discussed for arsenic, there are currently no children living on-site and it does not appear likely that small children from neighboring residences would access the site because of the distances involved.

Sediment Exposure Pathway

The exposure doses and cancer risk for the 2 chemicals in this pathway are displayed in Table E2. Possible health consequences are discussed in the following paragraphs.

Arsenic

Health effects in children or adults due to exposure to arsenic in sediment on this site appear unlikely based on the contaminant levels or likely exposure scenarios. As indicated in Table E2, the child exposure dose for both the mean and maximum arsenic levels exceed the health guideline, while the adult exposure dose for the mean and maximum levels does not. Thus, adults will not be considered further in evaluating the possibility of health effects for arsenic.

Health effects in children appear unlikely because they do not have the opportunity to have sufficient exposure to result in harm. The calculated exposure doses for children assume that an individual would have nearly daily contact with contaminated sediment several hours a day. As discussed for arsenic in soil, there are no children living on-site and it does not appear likely that small children from neighboring residences would access the site because of the distances involved.

Cadmium

Health effects in children or adults due to exposure to cadmium in sediment on this site appear unlikely based on the contaminant levels or the likely exposure scenarios. As indicated on Table E2, the child exposure dose for both the mean and maximum cadmium levels and the adult exposure dose for the maximum level exceed the health guideline. The adult exposure dose for the mean level does not.

Health effects in children appear unlikely because they do not have the opportunity to have sufficient exposure to result in harm. The calculated exposure doses for children assume that an individual would have nearly daily contact with contaminated sediment several hours a day. As discussed for arsenic in soil, there are currently no children living on-site and it does not appear likely that small children from neighboring residences would access the site because of the distances involved.

An adult would have to have prolonged contact with sediment contaminated at or near the maximum concentration of 189 ppm for 4 or 5 days a week. Currently, this is unlikely since no one works at the site. The individual living on-site would be at risk only if he went to the most contaminated areas nearly every day and spent several hours in contact with the sediment. This is unlikely.

Surface Water Exposure Pathway

The exposure doses and cancer risk for the chemical in this pathway are displayed in Table E3. Possible health consequences are discussed in the following paragraphs.

Arsenic

Health effects in children or adults due to exposure to arsenic in surface water on this site appear unlikely based on the contaminant levels and the likely exposure scenarios. As indicated in Table E3, the child and adult exposure doses for both the mean and maximum arsenic levels do not exceed the health guideline, so noncarcinogenic effects will not be considered further.

The cancer risk for the maximum and mean arsenic levels are elevated if someone were exposed to those levels nearly every day for 70 years. It appears unlikely that anyone could meet these exposure circumstances since no one works on site. The only person currently living on-site would have to have nearly daily contact with the contaminated areas to increase his risk of cancer.

Children and Other Susceptible Populations

As part of ATSDR's Child Health Initiative, the possibility of health effects in children due to exposures to site contaminants was carefully considered in this public health assessment. This evaluation indicates that health effects in children exposed to on-site contaminants are unlikely because exposure levels are too low to cause harm or because children would not have access to contaminated areas.

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their water, soil, air, or food. Children are at a greater risk than adults from certain kinds of exposures to hazardous substances emitted from waste sites and emergency events. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are more likely to come into contact with dust, soil, and heavy vapors close to the ground. Also, they receive higher doses of chemical exposure due to lower body weights. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

Lead contamination of soil and dust is a particular concern for small children (generally 6 years old and younger) because of the risk factors listed above. Although small children are not likely to be exposed to the soil at the TFM site itself; it is not known, at present, whether any slag material was removed from the site and deposited in residential areas. In addition, another smelter operated near the city of Collinsville in the past and may also be a source of lead contamination in the area. The amount of lead in the blood can be measured to determine if exposure to lead has occurred. The Centers for Disease Control and Prevention (CDC) recommends that young children be tested for lead poisoning, especially if the children have been in contact with lead-contaminated soil or dust (20). Thus, ATSDR concludes that it would be prudent public health practice to have the children under 6 years old in the Collinsville area tested for lead in their blood.

COMMUNITY HEALTH CONCERNS

ATSDR held a public availability session at the Collinsville City Hall Annex on July 27, 1999, to meet with area residents and gather any health concerns the community might have concerning the site. This public availability session followed a public meeting at which representatives of various government agencies were introduced and the site conditions were discussed.

In addition, ATSDR released an earlier version of this public health assessment, which was open for public comment from February 15 through March 24, 2000. The public comment period was announced in local newspapers and the public health assessment was available in the Collinsville Public Library; on W. Main Street in Collinsville, Oklahoma. Only one comment was received during this period.

The following public health concerns were posed at the meetings or in written comments:

1. *What about flooding in the area? Could that spread the contaminants?*

Response: Flooding could cause some contaminants to move off-site. However, since metals from the slag material would not easily dissolve in water, the flooding would have to move soil particles to significantly spread contamination. Most likely, flood water would follow the same drainage pathway that already exists; that is, it would flow to the ponds or southern impoundment and then flow to the east to Blackjack Creek. There were some environmental samples taken in Blackjack Creek, but more sampling is recommended.

2. *What are the effects on the wildlife?*

Response: The only wildlife sampled so far were the catfish caught in the southern impoundment. The few metals detected in the fillets were not above their comparison value and therefore are not

likely to cause adverse health effects in humans who consume them. ATSDR's mission is to evaluate human health effects from hazardous waste sites. Therefore, any impact to wildlife that would not affect human health is best addressed by the Environmental Protection Agency (EPA) or the Oklahoma Department of Environmental Quality (ODEQ).

3. *Was the goat (reported in the past to have wandered on-site) a milk goat and if so, who is drinking the milk?*

It is not known who owns the goat that has wandered on the site in the past or if it is used for milk (5). The sighting of a goat was reported to ODEQ, but was not observed by ATSDR or ODEQ. The on-site resident has not seen a goat on the property in recent years.

If additional information becomes available, ATSDR will evaluate this possible exposure pathway. Please contact Barbara Cooper, ATSDR, at 1-888-422-8737 (toll-free) if you have any information regarding goats on the old smelter site or other health concerns.

CONCLUSIONS

1. Currently, the TFM site poses no apparent health hazard because there is limited exposure to on-site soils, sediment, and surface water. Frequent, long-term exposure to on-site soil would be a health concern.
2. If the occupancy of the on-site residence changes in the future, exposure to site contaminants may increase and could pose a health hazard.
3. Past worker exposure, during the operation of the smelter, is an indeterminate health hazard since not enough information is available to assess the level of contaminants or the extent of exposure.
4. Because of limited sampling data and the possibility of disposal of slag material in residential areas, the off-site soil is concluded to be an indeterminate public health hazard. Given the unknown level or extent of lead contamination, it is prudent public health practice to have young children in the area tested for lead in their blood.
5. The groundwater on-site is not currently being used for drinking water and therefore is not a public health hazard. ATSDR is unable to evaluate possible future exposures because of limited groundwater sampling data.

RECOMMENDATIONS

1. Restrict access to the site.
2. Consider all possible residential exposure scenarios in determining soil removal or remedial actions on the site.
3. Encourage the population of Collinsville, and particularly the residents who live near the site, to bring their children ages 6 and under to the local Health Department for a free blood lead level screening.
4. Determine the extent of off-site contamination and the possibility of disposal of slag material in residential areas.
5. Determine if the groundwater is contaminated and, if warranted, prevent future exposure via on-site drinking water wells.

PUBLIC HEALTH ACTION PLAN

Public Health Actions Taken

1. ATSDR (along with EPA, ODEQ, OSDH, and local and tribal representatives) toured the site and held a public meeting/public availability session on July 27, 1999. Community concerns were collected at that time.

Public Health Actions Planned

1. ATSDR will review the environmental sampling results from the remedial investigation, including evidence of past off-site slag disposal. Based on these results, ATSDR will re-evaluate the need to monitor blood lead levels in the community and the need for health education or health risk communication.
2. ATSDR will work with the other government agencies to inform area residents of the possible hazards at the TFM site.

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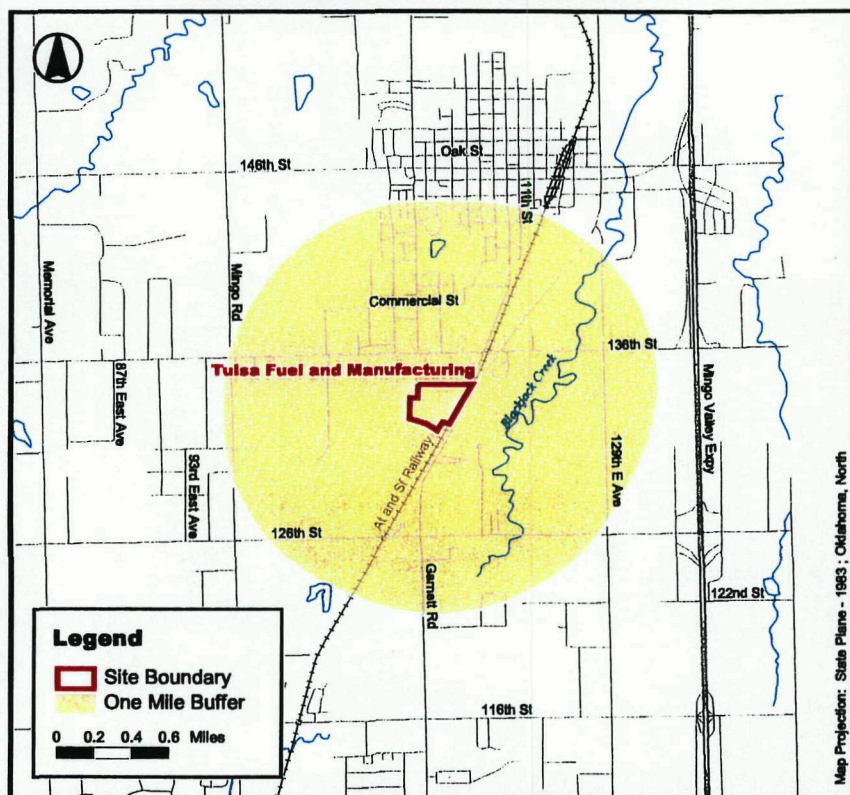
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APPENDICES

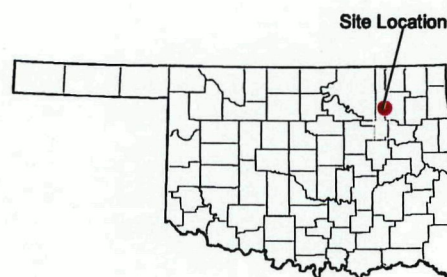
Tulsa Fuel and Manufacturing

Collinsville, Oklahoma

CERCLIS No. OKD987096195



Base Map Source: 1995 TIGER/Line Files

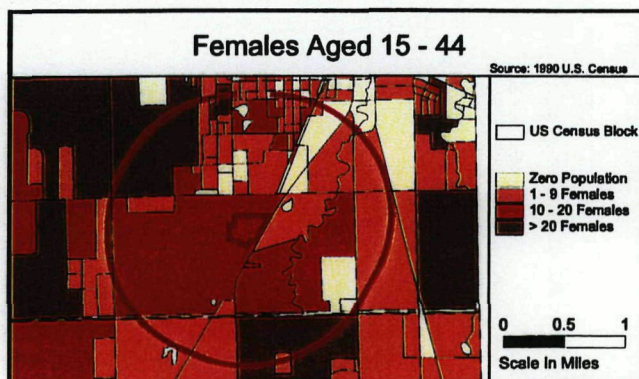
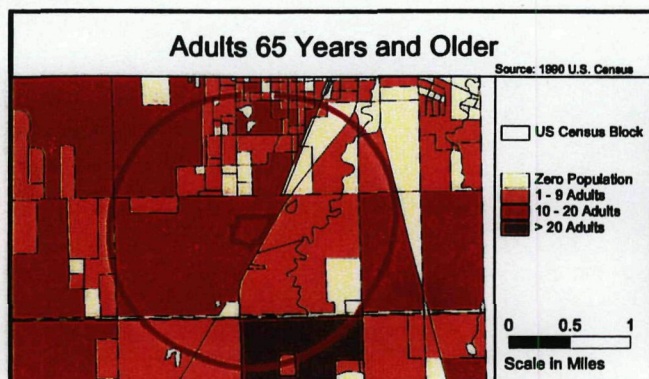
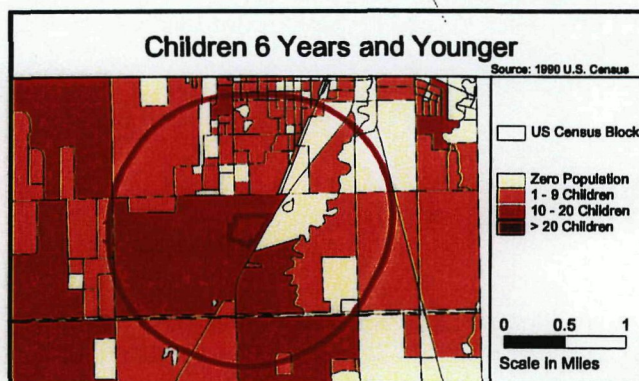
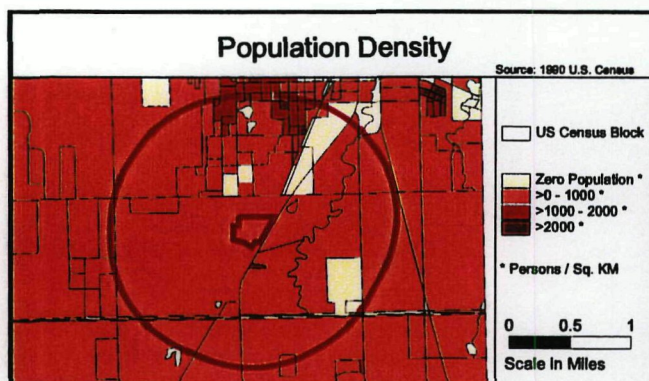


Tulsa County, Oklahoma

Demographic Statistics Within One Mile of Site*

Total Population	1463
White	1287
Black	0
American Indian, Eskimo, Aleut	174
Asian or Pacific Islander	2
Other Race	1
Hispanic Origin	6
Children Aged 6 and Younger	147
Adults Aged 65 and Older	193
Females Aged 15 - 44	305
Total Housing Units	745

Demographics Statistics Source: 1990 US Census
*Calculated using an area-proportion spatial analysis technique

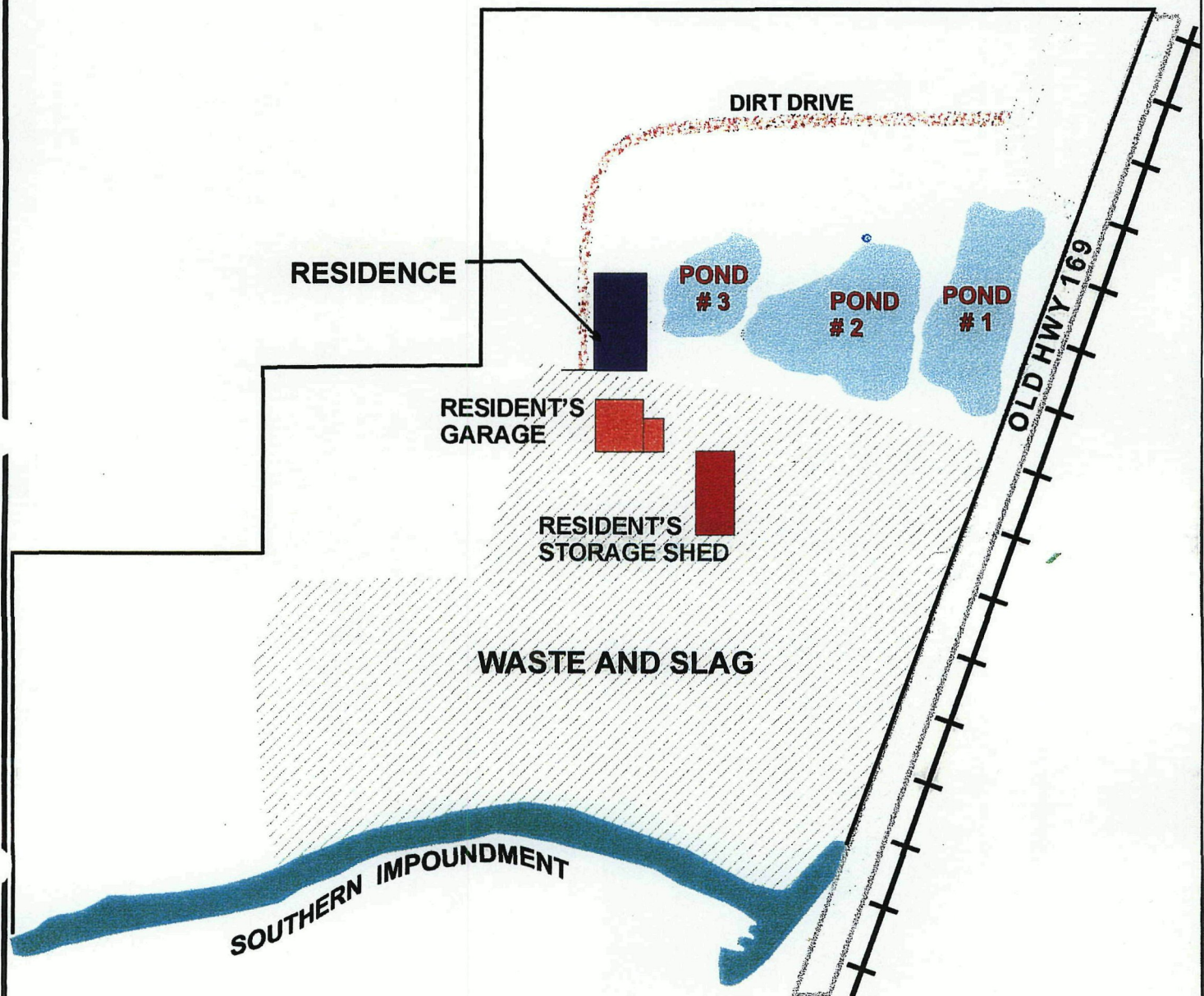


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Appendix A. Figure 1. Tulsa Fuel & Manufacturing site – location map and demographic information.

**FAITH ASSEMBLY CHURCH
PROPERTY**



SKETCH NOT TO SCALE



Ecology and Environment, Inc.
Region 6 START

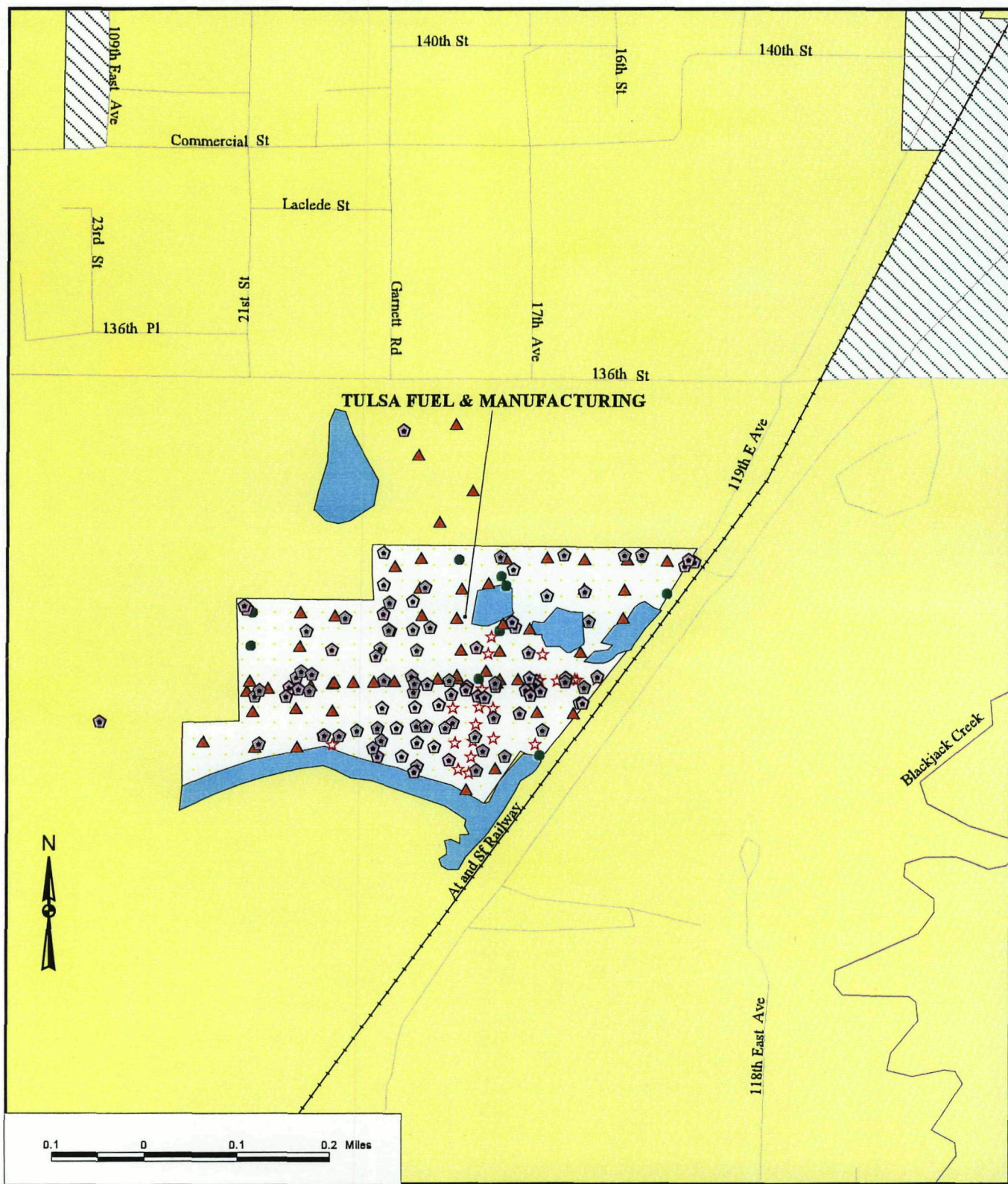
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CERCLA # OKD987096195

SOURCE : LOG BOOK

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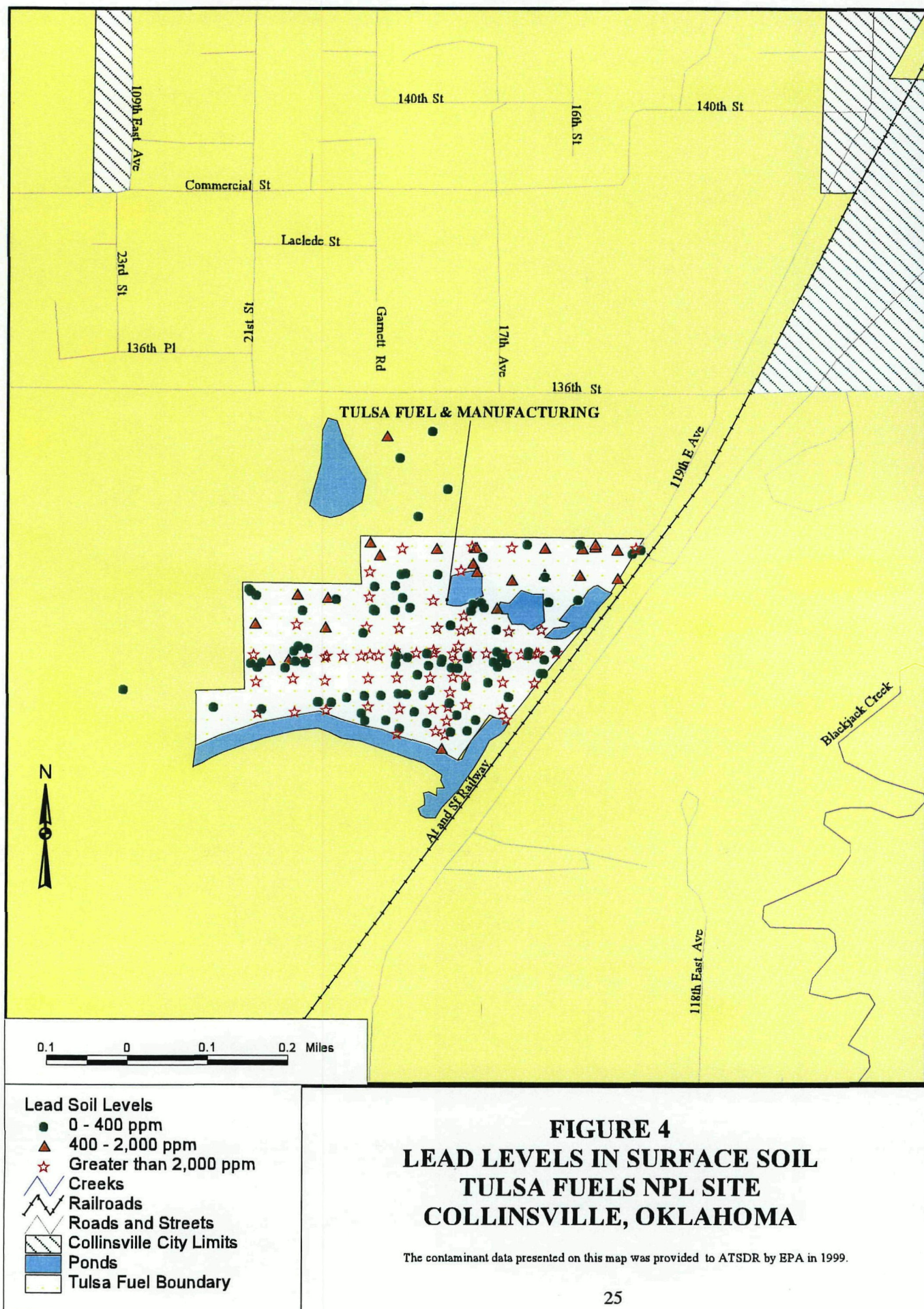
Appendix A. Figure 2. Tulsa Fuel & Manufacturing site – site sketch from Removal Assessment Report (4)

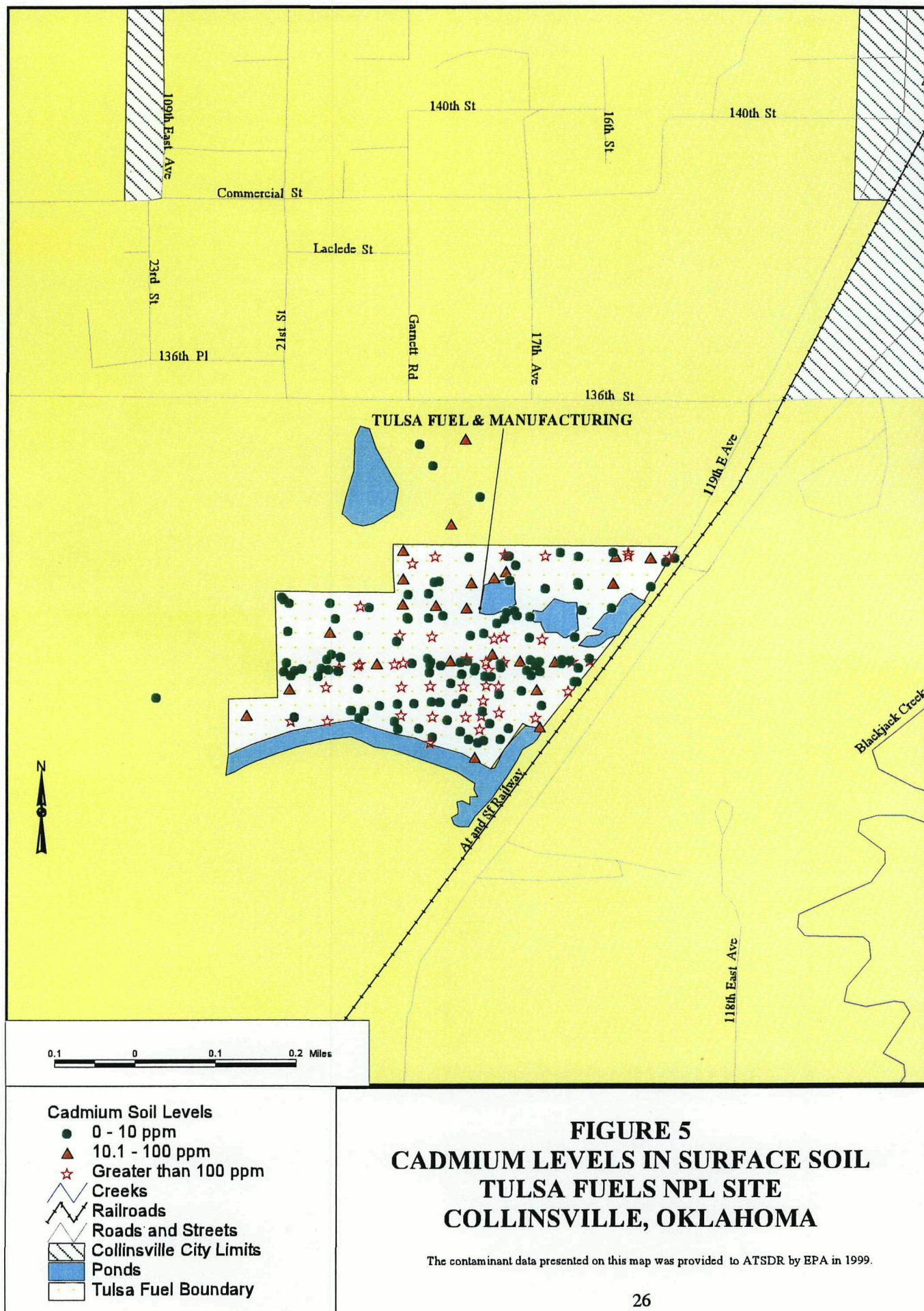


- Arsenic Soil Levels**
- ◻ 0 - 0.5 ppm
 - 0.5 - 20 ppm
 - ▲ 20 - 200 ppm
 - ★ Greater than 200 ppm
- Legend:**
- ~ Creeks
 - Railroads
 - Roads and Streets
 - ▨ Collinsville City Limits
 - Ponds
 - Tulsa Fuel Boundary

FIGURE 3
ARSENIC LEVELS IN SURFACE SOIL
TULSA FUELS NPL SITE
COLLINSVILLE, OKLAHOMA

The contaminant data presented on this map was provided to ATSDR by EPA in 1999.





Appendix B – Tables

Table B1. On-site Surface Soil Results, Tulsa Fuel & Manufacturing Site, Tulsa County, Oklahoma.

Contaminant	From Site Investigation, 9/94 ¹ n=7		From Removal Assess. Report, 5/99; XRF analysis ² n=106		From Removal Assess. Report, 5/99 TAL lab analysis ³ n=2		Comparison Value ⁴	
	Concentration Range (ppm)	Average (ppm)	Concentration Range (ppm)	Average (ppm)	Concentration Range (ppm)	Average (ppm)	Concentration (ppm)	Type
Arsenic	18.5 - 302	151	ND - 864	138	12.1 - 26.7	19.4	0.5 20	CREG EMEG-child
Cadmium	41.1 - 275	119	DNU	–	17.2 - 76.9	47.1	10	EMEG-child
Copper	126 - 1670	874	ND - 4023	659	87.3 - 122	105	2,000	estimated CV for child
Lead	1160 - 16,600	8539	138 - 36,565	4992	566 - 1560	1063	400	EPA SSL
Manganese	691 - 24,700J	10,610	ND - 45,655	5641	657 - 974	816	7,000	RMEG-child
Zinc	6770 -37,000J	20,714	694 - 104,232	27,842	3030 - 11,500	7265	20,000	EMEG-child

¹ Includes five 0-2 inch samples from waste piles and two 0-3 inch samples from on-site residential yard.

² Screening level analysis of 99 grid samples (0-6"), 5 road samples (0-2"), and 2 samples (0-6") from residential property.

³ Two surface soil samples sent to laboratory for confirmation purposes, one from residential property and one grid sample from northern portion of site.

⁴ The Comparison Values are defined on page 34.

n = number of samples

ppm = parts per million (or milligrams per kilogram)

ND = not detected

DNU = Data Not Usable because laboratory confirmation of this compound did not correlate well with XRF data.

J = estimated value

Table B2. On-site Subsurface Soil Results, from the Removal Assessment Report, 5/99. Tulsa Fuel & Manufacturing Site, Tulsa County, Oklahoma.

Contaminant	XRF analysis Slag samples from waste piles, 0-9 ft. n=37		XRF analysis Road samples, 2-24 inches n=6		TAL lab analysis ¹ n=6		Comparison Value ²	
	Concentration Range (ppm)	Average (ppm)	Concentration Range (ppm)	Average (ppm)	Concentration Range (ppm)	Average (ppm)	Concentration (ppm)	Type
Arsenic	ND - 1071	285	ND - 69	36	5.8 - 258	53.8	0.5	CREG
Cadmium	DNU	–	DNU	–	ND - 35.4	22.2	10	EMEG-child
Copper	ND - 2826	792	ND - 44	17	13 - 1130	225	2000	estimated CV for child
Lead	50 - 39,964	7604	3.4 - 986	350	14.4 - 91,800	15,722	400	EPA SSL
Manganese	323 - 56,320	18,382	216 - 1086	518	159 - 6540	1774	7000	RMEG-child
Zinc	396 - 79,511	30,841	139 - 7647	3465	42.7 - 25,200	5935	20,000	EMEG-child

¹ Five waste pile samples and 1 road sample were sent to the lab for confirmation purposes.

² The Comparison Values are defined on page 34.

n = number of samples

ppm = parts per million (or milligrams per kilogram)

ND = not detected

DNU = Data Not Usable because laboratory confirmation of this compound did not correlate well with XRF data.

Table B3. Off-site Surface Soil Results, Tulsa Fuel & Manufacturing Site, Tulsa County, Oklahoma.

Contaminant	From Site Investigation, 9/94 ¹ n=2		From Removal Assess. Report, 5/99; XRF analysis ² n=6		From Removal Assess. Report, 5/99 TAL lab analysis ³ n=1	Comparison Value ⁴	
	Concentration Range (ppm)	Average Concentration (ppm)	Concentration Range (ppm)	Average (ppm)	Concentration (ppm)	Concentration (ppm)	Type
Arsenic	10.4 - 13.7	12.1	ND - 48	33	5.56	0.5	CREG
Cadmium	4.2 - 6.2	5.2	DNU	—	0.85	0.4 10	EMEG-pica EMEG-child
Lead	226 - 362	294	ND - 700	166	14	400	EPA SSL
Manganese	521 - 548	535	205 - 893	490	323	300 7000	RMEG-pica RMEG-child
Zinc	892 - 786	839	360 - 3824	1094	311	600 20,000	EMEG-pica EMEG-child

¹ Two soil samples taken in residential yards, north of site on 136th St.

² The soil samples were taken within 800 ft. of the site, 5 from north of the site and 1 outside the southwest corner. They were labeled as background samples in the Removal Assessment Report.

³ One sample taken approximately 800 ft. north of the site.

⁴ The Comparison Values are defined on page 34.

n = number of samples

ppm = parts per million (or milligrams per kilogram)

ND = not detected

DNU = Data Not Usable because laboratory confirmation of this compound did not correlate well with XRF data.

Table B4. On-site Sediment Sample Results, Tulsa Fuel & Manufacturing Site, Tulsa County, Oklahoma.

Contaminant	Site Investigation, 9/94 n=4		Removal Assess. Report, 5/99 TAL lab analysis, n=29		Comparison Value ¹	
	Concentration Range (ppm)	Average Concentration (ppm)	Concentration Range (ppm)	Average Concentration (ppm)	Concentration (ppm)	Type
Antimony	ND - 50.9	18	ND - 20J	6.1	20	RMEG-child
Arsenic	7.8 - 514	157	ND - 110	14	0.5	CREG
Cadmium	13.9 - 1833	498	1.5 - 189	33	10	EMEG-child
Lead	160 - 25,400	8192	12 - 395J	129	400	EPA SSL
Manganese	741 - 6946	3894	35 - 2280J	856	7000	RMEG-child
Zinc	1590 - 22,900	12,780	101 - 4800	1300	20,000	EMEG-child

¹ The Comparison Values are defined on page 34.

n = number of samples

ppm = parts per million (or milligrams per kilogram)

ND = not detected

J = Estimated Value

Table B5. Surface Water Sample Results, Tulsa Fuel & Manufacturing Site, Tulsa County, Oklahoma.

Contaminant	Site Investigation, 9/94 n=4		Removal Assess. Report, 5/99 n=12		Surface Water Comparison Values ¹	
	Concentration Range (ppb)	Average Concentration (ppb)	Concentration Range (ppb)	Average Concentration (ppb)	Concentration (ppb)	Type
Arsenic	ND - 3.2 J	1.6	ND - 51	14	2.0 5000	CREG ² MCL ²
Cadmium	5 - 58.3	36	ND - 30	9.3	200 500	EMEG-child ² MCL ²
Lead	ND - 31.8	17	ND - 18	6.0	1500	EPA Action Level ²
Manganese	ND - 300	107	45 - 289	210	5000	RMEG-child ²

¹ Comparison Values are defined on page 34.

² Comparison Values for drinking water were multiplied by 100, because it was assumed that daily ingestion of surface water for a child was 10 ml rather than the 1000 ml used for drinking tap water.

n = number of samples

ppb = parts per billion (or micrograms per liter)

ND = not detected

J = Estimated Value

Table B6. Completed Exposure Pathways

Pathway Name/ Media: →	Surface Soil (On-site)	Sediment (On-site)	Surface Water
Source:	TFM	TFM	TFM
Exposure Point:	on-site surface soil/ waste piles	northern ponds, southern impoundments, ditches	northern ponds, southern impoundments, ditches
Exposure Route:	ingestion	ingestion	ingestion
Likely Exposed Population:	on-site residents visitors/trespassers smelter workers (1914-25)	on-site residents visitors/trespassers/fishers smelter workers (1914-25)	on-site residents visitors/trespassers/fishers smelter workers (1914-25)
Exposure Period:	past current future	past current future	past current future
Contaminants potentially of public health interest	metals - arsenic, cadmium, copper, lead, manganese, zinc	metals - antimony, arsenic, cadmium, copper, lead, manganese, zinc	metals - arsenic, cadmium, lead, manganese
Comments	Residential area has lower concentrations than waste piles. No children currently live on site. As this site is somewhat isolated, trespassing would be limited, but has occurred.	Exposure to sediments is limited. Past levels are not known.	This water is not used for drinking water; exposure would be incidental during recreational activities such as fishing. Swimming in the past has been reported .
NOTE: THE PRESENCE OF AN EXPOSURE PATHWAY IN THIS TABLE DOES NOT IMPLY THAT AN EXPOSURE WOULD BE SUBSTANTIVE OR THAT AN ADVERSE HEALTH EFFECT WOULD OCCUR			

Table B7. Other Pathways Considered

Pathway Name/ Media	Soil (off-site)	Surface Water (off-site)	Groundwater	Air	Sediment (off-site)	Biota/Food chain
Source:	TFM	TFM & possible Collinsville smelter	TFM	TFM	TFM & possibly Collinsville smelter	TFM
Exposure Point:	1) near site 2) possibly residential driveways, or anywhere smelter waste was deposited	ditches off-site and intermittent streams	on-site residence tap water	on-site	ditches off-site and intermittent streams	Residences nearby Wherever fish or berries or goat milk are consumed
Exposure Route:	ingestion inhalation (dust)	ingestion	ingestion	inhalation	ingestion	ingestion
Likely Exposed Population:	nearby residents	nearby residents, children playing in stream	on-site resident	past & future workers on-site resident	nearby residents, children playing in stream	nearby residents who ingest berries & fish gathered from site or ingest milk from goat which roams site.
Exposure Period:	past current future	past current future	future	past future	past current future	past current future
Contaminants potentially of health interest	metals	metals	metals	metals sulfur dioxide (during operation of smelter)	metals	metals
Comments	The extent of off-site soil contamination is unclear. The possibility of off-site disposal of slag/waste in driveways, roads, tracks exists, but has not been investigated.	Limited sampling. The downstream ditches and streams are not used for drinking water.	Limited sampling. One on-site well did not show metal contamination. Currently, on-site resident does not drink the well water.	Recent sampling shows no significant contamination. In the past, smelter workers could have been exposed SO ₂ , etc. Any future soil removal would have the potential to increase dust in air.	Limited sampling. Exposure would be limited.	Reports of fishing & berry-picking on-site have been made. Frequency is unknown. Low levels of a few metals were detected in catfish fillet. Berries have not been sampled. Goat has been seen on-site - no sampling data.
NOTE: THE PRESENCE OF AN EXPOSURE PATHWAY IN THIS TABLE DOES NOT IMPLY THAT AN EXPOSURE WOULD BE SUBSTANTIVE OR THAT AN ADVERSE HEALTH EFFECT WOULD OCCUR						

Appendix C – Comparison Values

EMEG = Environmental Media Evaluation Guide.

An estimated comparison concentration for which exposure is unlikely to cause adverse health effects, determined by ATSDR from its toxicological profiles for a specific chemical.

RMEG = Reference Dose Media Evaluation guide

A comparison concentration that is based on EPA's estimate of the daily exposure to a contaminant that is unlikely to cause adverse health effects.

CREG = Cancer Risk Evaluation Guide

A comparison concentration that is based on an excess cancer rate of one in a million persons and is calculated using EPA's cancer slope factor.

MCL = Maximum Contaminant Level

MCLs represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology).

EPA Action Level:

The estimated contaminant concentrations in water where additional evaluation is needed to determine if action is required to eliminate or reduce exposure. Action levels can be based on mathematical models.

EPA SSL = Environmental Protection Agency Soil Screening Level

A level of a contaminant in the soil that is used to identify areas needing further investigation at National Priority List (NPL) sites.

Appendix D – Evaluation Process

In evaluating these data, ATSDR used comparison values to determine which chemicals to examine more closely. Comparison values are health-based thresholds below which no known or anticipated adverse human health effects occur. Comparison values can be based on cancer or non-cancer health effects. Non-cancer levels are based on the lowest (i.e., most toxic) valid toxicological study for a chemical and the assumption that a small child (22 lbs.) is exposed every day. Cancer levels are the media concentrations where there would be a one in a million excess cancer risk for an adult eating contaminated soil everyday for 70 years. For chemicals for which both cancer and non-cancer numbers exist, the more toxic (i.e., lower) level is used. A description of the comparison values used in this evaluation can be found in Appendix C. Exceeding a comparison value does not mean that health effects will occur, just that more evaluation is needed.

Further evaluation focuses on identifying which chemicals and exposure situations are likely to be a health hazard. The first step is the calculation of child and adult exposure doses, as described in Appendix E. These are then compared to an appropriate health guideline for a chemical. An exposure dose is the amount of chemical ingested daily per unit of body weight. Health guidelines are the amount of chemical per unit of body weight where health effects very likely do not occur, based on investigations of human exposures to the chemical, or, if human data don't exist or are not valid, of animal experiments. Most health guidelines are based on animal data. The results of these calculations are presented in Tables E1 through E3 starting on page 37. Any exposure situation, where the exposure dose is lower than a health guideline, is eliminated from further evaluation.

The next step in the evaluation process is determining whether the worst case exposure situations used in earlier calculations need to be revised to better fit the actual situation.

The last evaluation step is the comparison of these revised exposure doses to known toxicological values for the chemical of concern. This would include the no observed and lowest observed adverse health effects levels (NOAEL & LOAEL) identified in ATSDR Toxicological Profiles. If the chemical of concern is a carcinogen, the cancer risk is recalculated using the revised exposure dose. These comparisons are the basis for stating whether the exposure might be a health hazard or not.

Appendix E – Calculation of Environmental Exposure Doses

Calculation of Exposure Dose from Ingestion of Contaminated Soil or Sediment

The exposure doses for ingestion of contaminated soil or sediment were calculated in the following manner. The maximum or mean concentration for a chemical in soil or sediment were multiplied by the soil ingestion rate for adults, 0.0001 kg/day, or the rate for children, 0.0002 kg/day. This product was divided by the average weight for an adult, 70 kg (154 pounds), or for a small child, 10 kg (22 pounds). Those calculations assume that there is frequent daily exposure to soil or sediment contaminated at the specified level. The results of the actual calculations are recorded in Tables E1 through E2 which are on the following pages.

Calculation of Exposure Dose from Ingestion of Contaminated Surface Water

The exposure doses for ingestion of contaminated surface water were calculated in the following manner. The maximum or mean concentration for a chemical in surface water was multiplied by a surface water ingestion rate for adults, 0.02 liters/day, or a rate for children, 0.01 liters/day. This product was divided by the average weight for an adult, 70 kg (154 pounds), or for a small child, 10 kg (22 pounds). Those calculations assume that there is daily exposure to surface water contaminated at the specified level. The results of the actual calculations are recorded in Table E3 which follows.

Calculation of Risk of Carcinogenic Effects

Carcinogenic risks from the ingestion of soil, sediment, or surface water were calculated using the following procedure. The adult exposure doses for ingestion of soil, sediment, or surface water were calculated as described previously, then multiplied by the EPA's Cancer Slope Factor (CSF) for that chemical (16). The results of the calculation of carcinogenic risk from exposure can be found on Tables E1 through E3 which are on the following pages.

The actual risk of cancer is probably lower than the calculated number. The method used to calculate EPA's Cancer Slope Factor assumes that high dose animal data can be used to estimate the risk for low dose exposures in humans (17). The method also assumes that there is no safe level for exposure (18). There is little experimental evidence to confirm or refute those two assumptions. Lastly, the method computes the 95% upper bound for the risk, rather than the average risk, which results in there being a very good chance that the risk is actually lower, perhaps several orders of magnitude (19). One order of magnitude is 10 times greater or lower than the original number, while two orders of magnitude are 100 times, and three orders 1,000 times.

TABLE E1 - ESTIMATED EXPOSURE DOSES AND CANCER RISK FOR ON-SITE SOIL CONTAMINANTS COMPARED TO HEALTH GUIDELINES FOR INGESTION¹

Contaminant	Level in parts per million (ppm)	Estimated Adult Exposure Doses in mg/kg/day*	Estimated Child Exposure Doses in mg/kg/day*	Health Guideline in mg/kg/day*	Source of Guideline	Cancer Risk
Maximum Arsenic Level	864	0.001	0.02	0.0003	MRL ²	2 in 1,000 ³
Mean Arsenic Level	138	0.0002	0.003	0.0003	MRL ²	3 in 10,000 ⁴
Maximum Cadmium Level	275	0.0004	0.006	0.0002	MRL ²	No CSF ⁵
Mean Cadmium Level	119	0.0002	0.002	0.0002	MRL ²	No CSF ⁵
Maximum Copper Level	4,023	0.006	0.08	0.04	pRfD ⁶	not carcinogen
Mean Copper Level	659	0.0009	0.01	0.04	pRfD ⁶	not carcinogen
Maximum Lead Level	36,565	0.05	0.7	None available ⁷	--	No CSF ⁵
Mean Lead Level	4,992	0.007	0.1	None available ⁷	--	No CSF ⁵
Maximum Manganese Level	45,655	0.07	0.91	0.14	RfD ⁸	not carcinogen
Mean Manganese Level	5,641	0.008	0.11	0.14	RfD ⁸	not carcinogen
Maximum Zinc Level	104,232	0.15	2.08	0.3	MRL ²	not carcinogen
Mean Zinc Level	27,842	0.04	0.56	0.3	MRL ²	not carcinogen

* mg/kg/day = milligrams/kilogram/day

1 An explanation of how these exposure doses and cancer risk were calculated can be found in the preceding page.

2 MRL = ATSDR's minimal risk level

3 Maximum additional lifetime risk of cancer per 1,000 individuals

4 Maximum additional lifetime risk of cancer per 10,000 individuals.

5 CSF = EPA's cancer slope factor

6 pRfD = EPA's provisional reference dose.

7 No health guideline is available for lead.

8 RfD = EPA's reference dose.

TABLE E2 - ESTIMATED EXPOSURE DOSES AND CANCER RISK FOR ON-SITE SEDIMENT CONTAMINANTS COMPARED TO HEALTH GUIDELINES FOR INGESTION¹

Contaminant	Level in parts per million (ppm)	Estimated Adult Exposure Doses in mg/kg/day*	Estimated Child Exposure Doses in mg/kg/day*	Health Guideline in mg/kg/day*	Source of Guideline	Cancer Risk
Maximum Arsenic Level	110	0.0002	0.002	0.0003	MRL ²	2 in 10,000 ³
Mean Arsenic Level	14	0.00002	0.0003	0.0003	MRL ²	3 in 100,000 ⁴
Maximum Cadmium Level	189	0.0003	0.004	0.0002	MRL ²	No CSF ⁵
Mean Cadmium Level	33	0.00005	0.0007	0.0002	MRL ²	No CSF ⁵

* mg/kg/day = milligrams/kilogram/day

1 An explanation of how these exposure doses and cancer risk were calculated can be found at the start of this appendix.

2 MRL = ATSDR's minimal risk level

3 Maximum additional lifetime risk of cancer per 10,000 individuals

4 Maximum additional lifetime risk of cancer per 100,000 individuals.

5 CSF = EPA's cancer slope factor

**TABLE E3 - ESTIMATED EXPOSURE DOSES AND CANCER RISK FOR SURFACE WATER CONTAMINANTS
COMPARED TO HEALTH GUIDELINES FOR INGESTION¹**

Contaminant	Level in parts per million (ppm)	Estimated Adult Exposure Doses in mg/kg/day*	Estimated Child Exposure Doses in mg/kg/day*	Health Guideline in mg/kg/day*	Source of Guideline	Cancer Risk
Maximum Arsenic Level	0.05	0.00001	0.00005	0.0003	MRL ²	3 in 100,000 ³
Mean Arsenic Level	0.01	0.000003	0.00001	0.0003	MRL ²	7 in 1,000,000 ⁴

* mg/kg/day = milligrams/kilogram/day
 1 An explanation of how these exposure doses and cancer risk were calculated can be found at the start of this appendix.
 2 MRL = ATSDR's minimal risk level
 3 Maximum additional lifetime risk of cancer per 100,000 individuals
 4 Maximum additional lifetime risk of cancer per 1,000,000 individuals.

Appendix F – ATSDR Plain Language Glossary of Environmental Health Terms

Adverse Health Effect:	A change in body function or the structures of cells that can lead to disease or health problems.
ATSDR:	The Agency for Toxic Substances and Disease Registry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level:	An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.
Biota:	Used in public health, things that humans would eat – including animals, fish and plants.
Cancer:	A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control
Carcinogen:	Any substance shown to cause tumors or cancer in experimental studies.
CERCLA:	See Comprehensive Environmental Response, Compensation, and Liability Act.
Chronic Exposure:	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be <i>chronic</i> .
Completed Exposure Pathway:	See Exposure Pathway.
Comparison Value: (CVs)	Concentrations or the amount of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):	CERCLA was put into place in 1980. It is also known as Superfund. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. ATSDR was created by this act and is responsible for looking into the health issues related to hazardous waste sites.

Concentration:	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant:	See Environmental Contaminant .
Dermal Contact:	A chemical getting onto your skin. (see Route of Exposure).
Dose:	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day”.
Dose / Response:	The relationship between the amount of exposure (dose) and the change in body function or health that result.
Duration:	The amount of time (days, months, years) that a person is exposed to a chemical.
Environmental Contaminant:	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in Background Level , or what would be expected.
Environmental Media:	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. Environmental Media is the second part of an Exposure Pathway .
U.S. Environmental Protection Agency (EPA):	The federal agency that develops and enforces environmental laws to protect the environment and the public’s health.
Epidemiology:	The study of the different factors that determine how often, in how many people, and in which people will disease occur.
Exposure:	Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see Route of Exposure .)
Exposure Assessment:	The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway:	<p>A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.</p> <p>ATSDR defines an exposure pathway as having 5 parts:</p> <ol style="list-style-type: none">1. Source of Contamination,2. Environmental Media and Transport Mechanism,3. Point of Exposure,4. Route of Exposure, and5. Receptor Population. <p>When all 5 parts of an exposure pathway are present, it is called a Completed Exposure Pathway. Each of these 5 terms is defined in this Glossary.</p>
Frequency:	<p>How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.</p>
Hazardous Waste:	<p>Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.</p>
Health Effect:	<p>ATSDR deals only with Adverse Health Effects (see definition in this Glossary).</p>
Indeterminate Public Health Hazard:	<p>The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.</p>
Ingestion:	<p>Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See Route of Exposure).</p>
Inhalation:	<p>Breathing. It is a way a chemical can enter your body (See Route of Exposure).</p>
LOAEL:	<p>Lowest Observed Adverse Effect Level. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.</p>
MRL:	<p>Minimal Risk Level. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.</p>

NPL:	The National Priorities List. (Which is part of Superfund .) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious, uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.
NOAEL:	No Observed Adverse Effect Level. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.
No Apparent Public Health Hazard:	The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.
No Public Health Hazard:	The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.
PHA:	Public Health Assessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.
Point of Exposure:	The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). For examples: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.
Population:	A group of people living in a certain area; or the number of people in a certain area.
Public Health Assessment(s):	See PHA.
Public Health Hazard:	The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria:	<p>PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:</p> <ul style="list-style-type: none">– Urgent Public Health Hazard– Public Health Hazard– Indeterminate Public Health Hazard– No Apparent Public Health Hazard– No Public Health Hazard
Receptor Population:	People who live or work in the path of one or more chemicals, and who could come into contact with them (See Exposure Pathway).
Reference Dose (RfD):	An estimate, with safety factors (see safety factor) built in, of the daily, life-time exposure of human populations to a possible hazard that is <u>not</u> likely to cause harm to the person.
Route of Exposure:	<p>The way a chemical can get into a person's body. There are three exposure routes:</p> <ul style="list-style-type: none">– breathing (also called inhalation),– eating or drinking (also called ingestion), and– or getting something on the skin (also called dermal contact).
Safety Factor:	<p>Also called Uncertainty Factor. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is <u>not</u> likely to cause harm to people.</p>
Source (of Contamination):	The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an Exposure Pathway .
Superfund Site:	See NPL.
Toxic:	<p>Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.</p>
Toxicology:	The study of the harmful effects of chemicals on humans or animals.
Urgent Public Health Hazard:	This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.